Documentation for lmoments

FORTRAN ROUTINES FOR USE WITH THE METHOD OF L–MOMENTS ––– VERSION 3.03
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Wrapped for Python by Michael Wehner, LLNL.
Some Fortran sources for executables are in Misc. The rest are in Src.

This library contains 56 routines for statistical analysis using L–moments,
and some auxiliary routines used by the L–moment routines. L–moments are
measures of location, scale and shape of probability distributions, similar
to the ordinary moments but estimable from linear combinations of order
statistics. For further information refer to the following publications.
IBM Research Reports are available in the IBM Research Cyberjournal at the
Internet address http://www.research.ibm.com:8080, or from the author at:
IBM Research Division, T.J. Watson Research Center, P.O. Box 218, Yorktown
Heights, N.Y. 10598, U.S.A.

J. R. M. HOSKING (1990). L–moments: analysis and estimation of distributions
using linear combinations of order statistics. Journal of the Royal Statistical
Society, Series B, 52, 105–124. (Theory and applications of L–moments.)

J. R. M. HOSKING (1996). Fortran routines for use with the method of L–moments,
Version 3. IBM Research Report RC20525. (Description of the routines in
this library.)

J. R. M. HOSKING and J. R. WALLIS (1997). Regional frequency analysis: an
approach based on L–moments. Cambridge, England: Cambridge University Press.
(Theory of L–moments, and their application to regional frequency analysis,
including details of the statistics calculated by routines REGLMR and REGTST.)

ROUTINES FOR SPECIFIC DISTRIBUTIONS
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The following routines are provided for each of eleven distributions.

FUNCTION CDFxxx The cumulative distribution function of the distribution.

FUNCTION QUAxxx The quantile function (inverse cumulative distribution
function) of the distribution.

SUBROUTINE LMRxxx Calculates the L–moment ratios of the distribution given
its parameters.

SUBROUTINE PELxxx Calculates the parameters of the distribution given its
L–moments. When the L–moments are the sample L–moments of
a set of data, then the resulting parameters are of course
the "method of L–moments" estimates of the parameters.

Here xxx is a 3–letter code that identifies the distribution, as follows:

EXP Exponential distribution
GAM Gamma distribution
GEV Generalized extreme−value distribution
GLO Generalized logistic distribution
GNO Generalized Normal (lognormal) distribution
GPA Generalized Pareto distribution
GUM Gumbel distribution
KAP Kappa distribution
NOR Normal distribution
PE3 Pearson type III distribution
WAK Wakeby distribution

For example, the cumulative distribution function of the Gumbel distribution is
FUNCTION CDFGUM.

ROUTINES FOR COMPUTING SAMPLE L−MOMENTS
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SUBROUTINE SAMLMR Calculates the sample L−moment ratios of a data set,
via the probability weighted moments.

SUBROUTINE SAMLMU Calculates the "unbiased" sample L−moment ratios of a data
set, by a more direct method.

SUBROUTINE SAMPWM Calculates the sample probability weighted moments of a
data set.

ROUTINES FOR REGIONAL FREQUENCY ANALYSIS
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SUBROUTINE CLUAGG Performs cluster analysis by one of several agglomerative
hierarchical methods: single−link, complete−link, and
Ward's procedure.

SUBROUTINE CLUINF Obtains information about clusters arising from
agglomerative hierarchical clustering.

SUBROUTINE CLUKM Performs cluster analysis by the K−means algorithm.

SUBROUTINE REGLMR Calculates regional weighted averages of L−moment ratios.

SUBROUTINE REGTST Calculates statistics useful in regional frequency
analysis: discordancy measures, heterogeneity measures
and goodness−of−fit measures, described in more detail
by Hosking and Wallis (1997).

PROGRAM XCLUST Program to illustrate the use of the cluster analysis
routines.

PROGRAM XFIT Program to illustrate the use of routine REGLMR. The
program performs frequency analysis of a regional data set
using an index−flood procedure and the method of L−moments.

PROGRAM XTEST Program to illustrate the use of routine REGTST. The
program uses REGTST to calculate test statistics for a
regional data set.

PROGRAM XSIM Program to illustrate the use of Monte Carlo simulation to
derive the properties of estimated quantiles in regional
frequency analysis.

AUXILIARY ROUTINES (used by the foregoing routines)
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FUNCTION DERF Error function.

FUNCTION DLGAMA Natural logarithm of the gamma function.

FUNCTION DIGAMD Digamma function.

SUBROUTINE DURAND Random number generator.

FUNCTION GAMIND Incomplete gamma function.

FUNCTION QUASTN Quantile function of the standard Normal distribution.

SUBROUTINE SORT Sorts an array into ascending order.

DATA FILES
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APPALACH.DAT Example data set for PROGRAM XCLUST: site characteristics
for 104 streamflow gaging stations in central Appalachia.

APPALACH.OUT The output when PROGRAM XCLUST is applied to the data in
APPALACH.DAT.

MAXWIND.DAT Example data set for PROGRAM XFIT: annual maximum windspeed
at 12 sites in the southeast U.S.

MAXWIND.OUT The output when PROGRAM XFIT is applied to the data in
MAXWIND.DAT.

CASCADES.DAT Example data set for PROGRAM XCLUST: L−moments of annual
precipitation data for 19 sites in the northwest U.S.

CASCADES.OUT The output when PROGRAM XTEST is applied to the data in CASCADES.DAT.

XSIM.OUT The output from PROGRAM XSIM.

XSIMH.OUT The output from a modified version of PROGRAM XSIM (parameters DSEED=619145091D0, NREP=100, NSIM=500, KPRINT=1; omit the section near the end between the dashed lines).

LINKS BETWEEN ROUTINES
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CDFGAM calls DERF, DLGAMA, GAMIND.
CDFGNO calls DERF.
CDFNOR calls DERF.
CDFPE3 calls DERF, DLGAMA, GAMIND.
CDFWAK calls QUAWAK.
LMRGAM calls DLGAMA.
LMRGEV calls DLGAMA.
LMRGNO calls DERF.
LMRKAP calls DLGAMA, DIGAMD.
LMRPE3 calls DLGAMA.
PELGAM calls DLGAMA.
PELGEV calls DLGAMA.
PELGNO calls DERF.
PELKAP calls DLGAMA, DIGAMD.
PELPE3 calls DLGAMA.
QUAGAM calls DERF, DLGAMA, GAMIND, QUASTN.
QUAGNO calls QUASTN.
QUANOR calls QUASTN.
QUAPE3 calls DERF, DLGAMA, GAMIND, QUAGAM, QUASTN.
CLUKM calls Applied Statistics Algorithm AS136 (see below).
REGTST calls most of the PELxxx, QUAxxx and auxiliary routines.
GAMIND calls DERF.

Algorithm AS136 is not included here. It is available from StatLib (http://lib.stat.cmu.edu/apstat/136).

CHANGES BETWEEN VERSIONS 2 AND 3
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The following routines were added.

CDFEXP
LMREXP
PELEXP
QUAEXP
SAMLMU
CLUAGG

CLUINF
CLUKM
XCLUST
XSIM

The following routines were modified.

CDFGUM Removed initialization of an unused variable.

CDFWAK Iterative procedure modified to reduce the (already small) chance that
it will fail to converge. Minor bug fixes.

LMRKAP Removed initialization of an unused variable.

PELGEV More accurate numerical approximation.

PELGNO Simpler and more accurate numerical approximation. Routine QUASTN
no longer required. Now returns PARA(2)=−1 if given XMOM(3) too large.

PELKAP Modified to reduce the chance of numeric overflow. In consequence,
two new values of the IFAIL parameter are possible.

REGTST Changed critical values for discordancy measure. Order in which output
is printed was changed: table of parameters now printed before table
of quantiles. Placement of IMPLICIT statement corrected: this can
cause minor changes in the simulation results returned by the routine.
Minor bugs and inconsistencies removed. Minor changes to comments.

XFIT Minor bug fix. Minor changes to comments.

XTEST Minor bug fixes. Minor changes to comments.

DLGAMA Minor bug fix.

DURAND Speed increased.

DERF Corrected error when argument of function was exactly zero.
Removed initialization of an unused variable.

CHANGES AT VERSION 3.01 (DECEMBER 1996)
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The following routines were modified.

XSIM Replaced call to nonexistent function CDFSTN by call to DERF.

CHANGES AT VERSION 3.02 (MARCH 1997)
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The following routines were modified.

CLUAGG Implemented single−link and complete−link clustering.

CLUINF Added validity check for parameters. Minor changes to comments.

XCLUST Minor change to FORMAT statement 6080.

XSIM Changed random number seed.

Data file XSIM.OUT was also changed, as a consequence of the change to PROGRAM XSIM.

CHANGES AT VERSION 3.03 (JUNE 2000)
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The following routines were modified.

REGTST CHARACTER variable declarations changed to conform with Fortran−77 standard.

XTEST CHARACTER variable declarations changed to conform with Fortran−77 standard.

XSIM RETURN statements replaced by STOP.

QUASTN Fixed: WRITE(6,7000) and FORMAT statement 7000 incompatible.

Data file APPALACH.OUT was changed, as a consequence of the change to PROGRAM XCLUST made at version 3.02.